Benefits of the Federal Fossil Energy R&D Program

Testimony of
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to the
Subcommittee on Energy
Committee on Science
U.S. House of Representatives
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Mr. Chairman and Members of the Subcommittee:

I am pleased to have this opportunity to describe some of the most prominent efforts in the Department of Energy's fossil energy research, development and demonstration program. Rather than outlining all of the activities we have underway in our program, I have organized this statement around some of our most notable accomplishments and the benefits that have accrued to the nation's energy industry and to the public.

Given the role that clean coal technologies play in President Bush's recently released National Energy Policy and the President's commitment to invest in a new generation of clean coal power technologies, my formal statement begins with a description of clean coal technology progress to date and the President's plan for new clean coal investments in the future:

The Clean Coal Technology Program

The Clean Coal Technology Program was a major government-industry initiative undertaken in combination with an ongoing coal research program to develop environmental solutions for the Nation's abundant coal resources.

Begun in 1986, the program was a response to concerns over acid rain, which is formed from sulfur and nitrogen pollutants emitted by coal-burning power plants and industrial operations, as well as by vehicles and other sources. As the program progressed, its goals broadened to include reductions in greenhouse gas emissions through enhanced fuel efficiencies – i.e., generating more electricity using less fuel with fewer carbon dioxide emissions.

Industry-proposed projects were selected through a series of five national competitions aimed at attracting promising technologies that had not yet been proven commercially.

Ultimately, 38 pioneering projects in 18 states became part of the Clean Coal Technology Program. The public-private partnerships formed in this program involved:

- More than 55 individual electric generators serving customers in 33 states;
- Utilities that operate more than 170,000 megawatts, about 23% of U.S. capacity and consume 36% of U.S. coal production; and
- More than 50 technology developers and 30 engineering, constructing or technical service providers.

The federal government's funding share totaled $1.8 billion - actually below the original government estimate of $2.5 billion. The private sector, on the other hand, exceeded expectations, contributing $3.5 billion or nearly two-thirds of total project costs, well above the legally-mandated requirement of 50% non-federal financing.

Why Clean Coal?

Coal is the United States' most abundant domestic energy resource. One quarter of all the world's known coal supplies are found within the United States. In terms of energy value (Btus), coal constitutes approximately nearly three-fourths of U.S. fossil energy reserves.

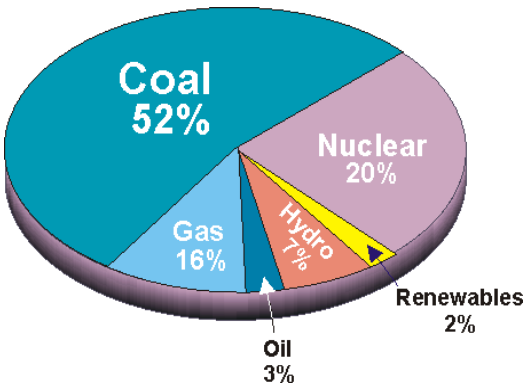
Our nation's recoverable coal has the energy equivalent of about one trillion barrels of crude oil -- comparable to all the world's known oil reserves. At today's consumption rates, U.S. coal reserves could last at least 250 years.

Coal is also an energy bargain. Historically it has been the least expensive fossil fuel available in the United States, and in contrast to other primary fuels, its costs are likely to remain stable or decline as mine productivity continues to increase. During the past decade, in fact, coal prices at U.S. steam electric power plants actually declined about 18%, in nominal terms, while petroleum and natural gas prices increased by 31% and 11%, respectively.

Because of its abundance and low cost, coal now accounts for more than half of the electricity generated in the United States.

The nation is likely to use more coal in the future, especially as strong economic growth, including the expanding digital economy, creates new demands for electricity.

Even with the large projected growth in other power generation fuels - especially natural gas - coal will continue to supply about half our electric power for at least another 20 years. Because of the overall increase in power demand, the Energy Information Administration forecasts that the nation will likely require nearly 20 percent more coal be used by 2020.



Fuel Sources for Electricity Generation in 2000 (Source: Energy Information Administration)

Given that the United States needs all the electricity it can generate from its most reliable and stable resources, coal can remain one of America's greatest energy strengths - especially if new technology can reduce environmental impacts and help keep the nation's energy affordable.

The Clean Coal Power Initiative

The Bush Administration is proposing a new vision for research into clean coal technology, pledging to invest $2 billion in clean coal power technology over the next 10 years. In setting the direction for new, competitively awarded clean coal research, development and demonstration efforts, greater emphasis will be placed on seeking the advice of industry in shaping the program. We intend to investigate the use of consortia of companies, an industry board, or other mechanisms that can enhance the private sector's participation in planning this initiative.

The program will also solicit participation by universities as well as government laboratories in a broad-based effort to apply the best minds and institutions to eliminate the barriers to enhanced coal use. Successfully implemented elsewhere in DOE, industry-guided research will choose the most important projects based on industry-defined merit.

This is an investment well worth making. The President's initiative builds on a solid track record of accomplishments that have resulted from the federal government's significant investment in clean coal technologies in the late 1980s and 1990s. From that investment has come:

Cleaner Air Made More Affordable. Tight new environmental standards enacted in 1990 as part of the Clean Air Act Amendments put America's utilities and factories on a new path toward sharp reductions in air emissions. For many companies, the combination of coal research and development and the Clean Coal Technology Program provided better options to meet the more stringent regulations while at the same time, continuing to fuel America's astounding economic growth during the 1990s.

The following chart of the 38 Clean Coal Technology projects shows that 22 of the original projects have achieved commercial success – either by continuing to operate with private sector financing or by being sold and replicated in other commercial applications.

[NOTE: Several of the 38 are still in the design, construction or testing phase, therefore it is likely that the number of commercial "success stories" will increase in the future.]

Clean Coal Technology Scorecard			
✔	**Commercial successes to date** (domestic or international sales made, or technology continues to operate commercially at plant site)		
	Project	**Company**	**Location**
✔	Gas Suspension Absorption	AirPol	W. Paducah, KY
	Confined Zone Dispersion	Bechtel	Seward, PA
✔	LIFAC Sorbent Injection	LIFAC	Richmond, IN
✔	Advanced Flue Gas Desulfurization	Pure Air on the Lake	Chesterton, IN
✔	CT-121 Flue Gas Scrubber	Southern Company Services	Newnan, GA
✔	NOx Control - Wall-Fired Boilers	Southern Company Services	Coosa, GA
	Coal Reburning	Babcock & Wilcox Co.	Cassville, WI
✔	Low-NOx Cell Burner	Babcock & Wilcox Co.	Aberdeen, OH
✔	Gas Reburning/Low-NOx Burners	EERC	Denver, CO
	Micronized Coal Reburning	NYSEG	Lansing, NY
✔	Selective Catalytic Reduction	Southern Company Services	Pensacola, FL
✔	NOx Control - Tangentially Fired	Southern Company Services	Lynn Haven, FL
✔	SNOX Flue Gas Cleaning	ABB	Niles, OH
✔	LIMB SO2/NOx Control	Babcock & Wilcox Co.	Lorain, OH
	SOx-NOx-ROx Box	Babcock & Wilcox Co.	Dilles Bottom, OH
	Gas Reburning/Sorbent Injection	EERC	Hennepin/Springfield, IL
✔	Milliken Clean Coal Project	NYSEG	Lansing, NY
✔	Dry NOx/SOx Control System	Public Service Co. of Colorado	Denver, CO
	McIntosh PFBC Project (4A)	City of Lakeland	Lakeland, FL
	McIntosh PFBC Project (4B)	City of Lakeland	Lakeland, FL
	JEA Fluidized Bed Project	JEA	Jacksonville, FL
✔	Tidd PFBC Project	Ohio Power Company	Brilliant, OH
✔	Nucla Circulating Fluidized Bed Proj.	Tri-State	Nucla, CO
✔	Tampa Electric IGCC Project	Tampa Electric Power Co.	Mulberry, FL

✔	Wabash River Repowering	Dynegy/PSI	West Terre Haute, IN
	Kentucky Pioneer Project	Kentucky Pioneer	Trapp, KY
	Pinon Pine Power Project	Sierra Pacific Power Corp.	Reno, NV
	Clean Coal Diesel Project	A.D. Little, Inc.	Fairbanks, AK
	Healy Clean Coal Project	AIDEA	Healy, AK
✔	Liquid Phase Methanol Synthesis	Air Products & Chemicals	Kingsport, TN
✔	Advanced Coal Conversion	Western Syncoal	Colstrip. MT
✔	Coal Quality Expert	CQ Inc., & ABB	Multiple Sites
✔	ENCOAL Mild Gasification	ENCOAL Corp.	Gillette, WY
	Integrated Coal/Ore Reduction	CPICOR	Vineyard, UT
	Pulse Combustor	MTCI	Baltimore, MD
✔	Blast Furnace Direct Coal Injection	Bethlehem Steel	Burns Harbor, IN
	Cyclone Combustor	Coal Tech Corp.	Williamsport, PA
	Cement Kiln Recovery Scrubber	Passamaquoddy Tribe	Thomaston, ME

U.S. utilities, to meet America's growing power demands, increased coal use 60% between 1980 and 1998. Yet, because of new technology and market-based emission compliance policies, the nation's power plants reduced emissions of sulfur dioxide by 22% and emissions of nitrogen oxides by 13%. Moreover, under today's regulatory strategies, further reductions are occurring. Preliminary indications show nitrogen oxides, for example, dropping another 10% in 2000.

Consumer Benefits. Clean coal technology has helped the U.S. power industry meet new emission standards and, at the same time, keep electric bills relatively low.

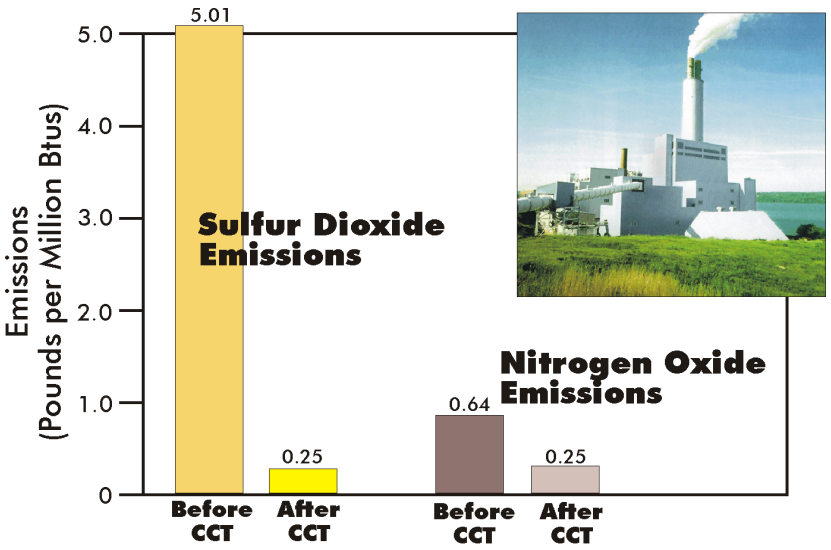
Americans pay over $200 billion a year for electricity. Yet, U.S. citizens still enjoy some of the lowest electric rates of any free market economy in the world. Low cost coal is a major reason. The lower cost clean coal technologies that became available in the 1990s are one reason why the nation's utilities could meet new environmental standards without imposing harsh price hikes on ratepayers.

Some of the specific benefits from the federal investment to date in clean coal technologies include:

- ***Reducing Smog - NOx Controls:*** Before the Clean Coal Technology Program, most options for significantly reducing smog-forming nitrogen oxide (NOx) pollutants were untried and expensive, in some cases, costing $3,000 per ton of pollutant removed. The Clean Coal Technology Program demonstrated new ways to reduce nitrogen oxides at lower costs.

  The result is that 75% of the existing coal-fired generating units have been or are currently being retrofitted with low-NOx burners that can reduce nitrogen oxide emissions at costs of less than $200 per ton.

  For utilities operating in areas where even more stringent air emission standards are in place, the Clean Coal Technology Program showed how "selective catalytic reduction" could be applied more reliably using U.S. coals. This technology now costs half what it cost in the 1980s, and systems are on order or under construction on 30% of U.S. coal-fired generating capacity.



The Milliken Clean Coal Project in Lansing, NY, showed how emissions from an existing coal plant could be significantly reduced by installing new pollution control technology.

  Because of these improvements, U.S. utilities are projected to reduce nitrogen oxide emissions by 25 million tons *more* than would have been the case without the clean coal research and demonstration program – and do so cost-effectively.

- ***Reducing Acid Rain - Flue Gas Cleanup:*** When the Clean Coal Technology Program began, flue gas desulfurization units - or "scrubbers" - were already being installed on many of the nation's power plants. But scrubbers were expensive and difficult to operate, and early technologies were unreliable. The Clean Coal Technology Program sponsored tests of new types of scrubbers with higher reliability and lower costs. The technological advances stimulated manufacturers to make improvements in virtually all scrubbers.

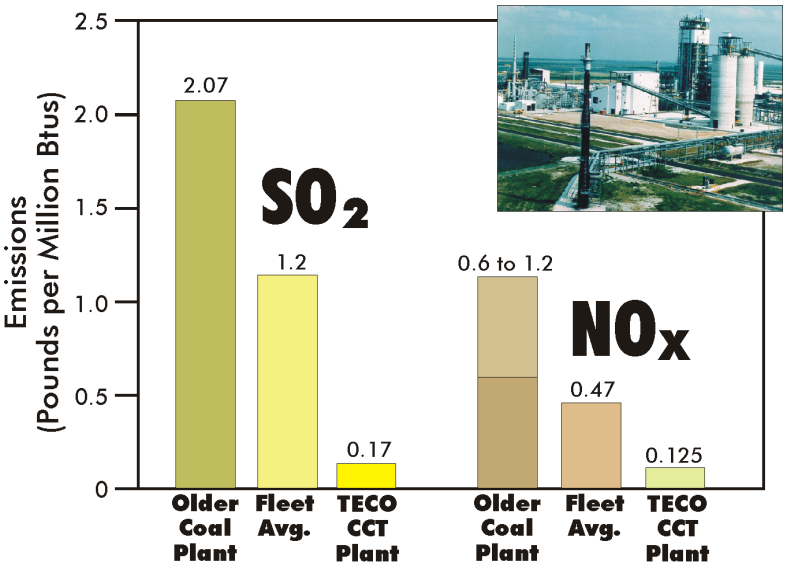
  Flue gas desulfurization systems now cost one-third what they did in the 1970s, and more than 400 commercial units have been deployed.

- ***Powering the 21st Century - The Next Generation of Power Plants:*** Prior to the Clean Coal Technology Program, the technology for coal-fired power plants was generally limited to the pulverized coal boiler - a large furnace-like unit that burns finely-ground coal. The Clean Coal Technology Program demonstrated alternatives with higher fuel efficiencies and superior environmental performance.

For example, a "fluidized bed" combustor -- a technology that can trace much of its roots to early federal research -- has the inherent advantage of burning virtually any type of coal (and other fuels) while removing pollutants inside the boiler. No scrubber or nitrogen oxide control system is needed.

Although used in small-size industrial applications, e.g., factories, chemical plants, steam heating plants, etc., they had not been tested at utility power plant scales. The Clean Coal Technology Program showed that utility-size fluidized bed combustors could be operated reliably. As a result, nearly $8 billion in commercial sales have been made.

The Clean Coal Technology Program also introduced a new way to use coal to generate electricity. Rather than burning, coal could be gasified - i.e., turned into a combustible gas. In gaseous form, virtually all pollutant-forming impurities can be removed. The coal gas can be made as clean as natural gas. Like natural gas, it could be burned in a gas turbine-generator, and the turbine exhaust used to power a steam turbine-generator. This "combined cycle" approach raised the prospects of unprecedented increases in fuel efficiency.



Tampa Electric's Polk Power Station has helped pioneer coal gasification-combined cycle technology, one of the cleanest ways to generate electricity from coal.

Gasification combined cycle plants built as part of the Clean Coal Technology Program near Tampa, Florida, and West Terre Haute, Indiana, are the cleanest, most efficient coal plants in the world. Today, gasification combined cycle is rapidly gaining favor around the world. Over 1500 megawatts are operating using coal today, and another 1900 megawatts are gasifying refinery wastes. Another 2200 megawatts are in the design stage.

Why a New Clean Coal Commitment?
Many of the innovations likely to emerge from the President's new effort will be directed at new challenges largely unanticipated at the time of the original Clean Coal Technology Program:

- *Tighter Air Quality Standards:* The original Clean Coal Technology Program began in the mid-1980s as a response to increasing concerns over acid rain, and especially the impact of acid rain pollutants drifting into the Northeast and across the U.S. border into Canada. Midway through the program, Congress passed the 1990 Clean Air Act Amendments which set new pollution standards for sulfur dioxide and nitrogen oxide emissions.

  Since the Clean Air Act Amendments were enacted, even more stringent environmental standards have been put into place - most of which directly affect coal-burning power plants. For example:

  S The Environmental Protection Agency has promulgated new regulations to reduce the regional transport of ozone (a pollutant that can cause smog and visibility problems), which will require eastern utilities to sharply reduce nitrogen oxide emissions below levels in the 1990 Clean Air Act Amendments.

  S The National Ambient Air Quality Standards, revised in 1997, are intended to reduce the levels of airborne particulate matter -- including ultra-tiny particles. Since gaseous emissions of nitrogen oxides and sulfur dioxide can condense in the atmosphere and form these small particles, the new rules will require further reductions in these pollutants.

  S Mercury: Trace amounts of mercury are released when coal is burned. The Environmental Protection Agency intends to propose new mercury control regulations by December 2003. At this point, however, there is no consistent, reliable technology for removing mercury that works for all boiler types used in coal-fired power plants.

  With new, lower cost technology, power plants that might otherwise be retired, or whose generating output might be reduced, can be kept in operation and in compliance with new air quality requirements. New power plants can be built with even better environmental performance. Both will be especially necessary at a time when consumers are demanding more electricity, not less.

- *The Nation's Appetite for Electricity Continues to Grow.* Today's best forecasts indicate that from 1999 to 2020, electricity demand in the United States will increase by 45 percent. The projected rise in demand would require the construction of 1,300 to 1,900 new power plants – about 65 each year. The nation has not experienced that type of capacity growth in the last 15 years.

Moreover, this could be a conservative estimate. Throughout the 1990s, actual electricity consumption far outstripped the best projections - driven largely by an expanding economy.

- *New Technologies Have Emerged.* The computer revolution since the mid-1990s has also played an important role in the development of new power plant technologies. New computer-aided control systems, running off neural networks and artificial intelligence, could make it possible to fine-tune combustion processes to their peak efficiency - not only boosting the amount of electricity an existing plant can generate but also helping it to reduce air emissions.

  Improved burner designs, better gas cleaning systems, higher performance turbines and fuel cells are just a few examples of new technologies that can generate electricity from coal with unprecedented emission reductions and higher fuel efficiencies. Increasing fuel efficiency not only makes pollution control more cost-effective, it also reduces the release of greenhouse gases - making it one of the most affordable ways to deal with concerns over climate change.

  Ultimately, the early prototypes of a virtually "zero-emission" coal-based energy plant could emerge from the Department's coal research and development program. The Department has termed the effort the "Vision 21" program -- a concentrated research and development program designed to produce a pollution-free, coal-based power plant by 2015. The Clean Coal Technology Program has shown how several new technologies – from coal gasification to advanced coal-to-liquids production – could make this multi-fuel, multi-product energy plant possible.

The Gas Turbine of Tomorrow

While the Clean Coal Technology Program was one of the largest and most diverse public-private initiatives to improve the way electricity is generated, other government-industry partnerships have also produced significant successes. One of the most significant has been the successful partnership of government and industry to accelerate development of a "breakthrough" gas turbine. This program is now drawing to a conclusion, having successfully produced its desired goals.

Natural gas turbines are likely to dominate the power generating market in the foreseeable future. For many years, however, gas turbine manufacturers faced a barrier that, for all practical purposes, capped power generating efficiencies for turbine-based power generating systems. The barrier was heat. Above 2300 degrees F, the scorching heat of combustion gases caused metals in the turbine blades and in other internal components to begin degrading. Since higher temperatures are the key to higher efficiencies, this effectively limited the generating efficiency at which a turbine power plant could convert fuel into electricity.

In February 2000, GE Power Systems unveiled the first gas turbine slated for the U.S. market that would break through the temperature barrier and push efficiencies to unprecedented levels. Using advanced materials and revolutionary new steam-cooling technology, the new turbine is capable of operating at 2600 degrees F.

The H System™ gas turbine was one of the culminating achievements of the Department of Energy's Advanced Turbine System research program. Designed to work in a combined cycle mode (i.e., in combination with a steam turbine generator), the H System will be the first to surpass the 60 percent efficiency threshold - the *"four minute mile"* of turbine technology. Moreover, the H System™ will operate cleaner than any of today's utility gas turbines. Its nitrogen oxide emissions levels of 9 parts-per-million without additional external controls will be half the average of the turbines now in use, making the technology suitable for siting in some of the Nation's most environmentally constrained areas.

The unit announced in February 2000 will be one of two advanced turbines that will power the 800-megawatt Heritage Station in Scriba, New York. The power plant, being built by Sithe Energies, one of the Nation's leading independent power generators, is scheduled to go online during 2002.

Innovations from DOE's turbine R&D program have already found their way into commercial plants. In April 2001, the Millennium power plant in Charlton, MA, came online using advanced gas turbine technology developed in DOE's program. At the core of the 360-megawatt natural gas combined cycle plant, owned by PG&E National Energy Group, is a Siemens Westinghouse Power Corp. gas turbine that incorporates advanced compressor technology, improved materials and seals, and new combustor enhancements developed as part of DOE's program. Siemens Westinghouse plans to have an even more advanced machine on the market in 2004/5 that will be the major product of its joint development effort with the department.

Fuel Cells - A New Power Source

Fuel cells are a technology with the potential to fundamentally change the nature of electric power generation. What makes fuel cells attractive is that they can produce high-quality power from hydrocarbon fuels without combustion.

The basic concept of fuel cells has been known for more than a century. They began to receive serious attention in the 1950s and 60s when NASA chose them as the best technology for producing power onboard the Gemini and Apollo spacecraft. These early cells required pure hydrogen and oxygen fuels and used high-cost materials such as platinum electrodes. Over the past three decades, significant effort has been expended to develop practical and affordable designs for stationary power production.

Today, fuel cell costs continue to be reduced, although they are still well above those of more conventional power sources. Nonetheless, the first fuel cells have moved into commercial applications. Nearly 200 "first generation" phosphoric acid fuel cells -- the product of DOE's R&D program in the 1970s and early 1980s -- are now installed worldwide.

Since the mid-1980s, the Department's fuel cell research funding has been focused primarily on technologies that work at higher temperatures, generating power more efficiently and improving the economic outlook for this new power generating approach. In recent months, significant milestones have been achieved that have raised optimism that advanced generations of fuel cells will soon cross over the commercial threshold. For example:

- **Fuel Cell Energy Corp.** has "cut the ribbon" for its new fuel cell manufacturing facility in Torrington, CT. Incorporating several new manufacturing methods developed in DOE's program, the new facility will increase the company's fuel cell production capacity 10-fold, a production rate of 50-megawatts per year. This facility will be the largest in the world for the manufacturing of molten carbonate fuel cell systems.

  The company, which has been a partner in DOE's fuel cell program since the 1970s, is also receiving its first orders for commercial-scale "market entry" fuel cells. Its 250 kW Direct FuelCell® power plant unit will be installed by the Los Angeles Department of Water and Power this year (the utility has also ordered two more units); another unit will help power the Mercedes-Benz U.S. International, Inc., plant in Tuscaloosa, AL, with funding from Southern Company, the Alabama Municipal Electric Authority, and FuelCell Energy; a third unit recently began generating power for the Rhon-Klinikum Hospital in Bad Neustadt, Germany; and the company recently announced an agreement with King County, WA, to supply a fuel cell that will be fueled by wastewater digester gas from the South Wastewater Treatment Facility in Renton, WA.

- **Siemens Westinghouse Power Corporation**, also a long-time partner in DOE's fuel cell program, is moving its all-ceramic solid oxide fuel cell into commercial-scale development. An early prototype 100-kilowatt unit recently achieved a world-record 16,598 hours of operation at a power plant in the Netherlands, and the company is preparing to demonstrate a 250-kilowatt fuel cell-turbine hybrid unit at the National Fuel Cell Research Center in Irvine, CA. A 1-megawatt unit is planned for the Environmental Protection Agency's laboratory at Ft. Meade, MD. Siemens Westinghouse has also received two major European contracts to install solid oxide fuel cell power systems in Essen, Germany, and Milan, Italy, in 2002, and recently, the company signed an agreement with four European utilities to install a fuel cell-turbine hybrid system in Marbach, Germany in 2003.

At current costs of $2,500 to $4,000 per kilowatt, fuel cell technology is still considerably more expensive than comparable gas turbine based power systems. Even if costs are reduced to the $1,000 to $1,200 per kilowatt range, the technology will largely be demand only for applications where premium-quality, onsite power is critical to commercial operations or where environmental restrictions limit other types of power sources.

It may be possible, however, to reduce future fuel cell costs to as low as $400 per kilowatt – a cost that will make the technology highly competitive with virtually any power source. DOE is investing in a new Solid State Energy Conversion Alliance (SECA) that focuses the efforts of government, commercial developers, universities, and national laboratories on bringing to fuel cell technology the same advancements that have revolutionized the solid state electronics industry. The basic building block of the SECA effort will be a 5-kilowatt solid state fuel cell module that can be "mass customized" for use in residential or auxiliary power units, or linked together like batteries for larger power applications.

Deeper, Faster, Smarter, Cleaner – DOE's Oil and Gas Successes

Oil and natural gas remain the dominant fuels in the U.S. economy, providing 62 percent of the nation's energy and almost 100 percent of its transportation fuels. By 2020, the Energy Information Administration expects the United States to need about 50 percent more natural gas and one-third more oil to meet demand.

When the National Energy Policy Development Group presented its report a few weeks ago, it included two recommendations that emphasized the importance of new technology for the U.S. oil and gas industry:

- *The NEPD Group recommends that the President direct the Secretaries of Energy and the Interior to promote enhanced oil and gas recovery from existing wells through new technology;*

- *The NEPD Group recommends that the President direct the Secretary of Energy to improve oil and gas exploration technology through continued partnership with public and private entities.*

The emphasis in the President's National Energy Policy on advanced technology for oil and gas exploration and production is well-founded. Finding, developing, and producing oil and gas today is an extremely high-tech venture, with private industry relying on cutting edge innovations that rival the most sophisticated technologies of any of our most advanced modern-day industries.

New oil and gas technologies have proven their worth – both in terms of providing vital oil and gas supplies from domestic fields to improving environmental protection in and around oil and gas operations. For example, technological advances have enabled oil and gas producers to:

- *Access new frontiers* -- It is now possible to drill in deeper waters, deeper in the earth, in the cold frontiers of the arctic, and in new resource settings such as coal seams, all thought uneconomic not too many years ago.

- *Find oil and gas more efficiently* -- Drilling success rates have doubled in the last two decades, resulting in fewer dry holes.

- *Find more oil and gas per well drilled* -- Today, fewer than half as many wells must be drilled to locate the same amount of oil and gas reserves as two decades ago.

- *Reduce costs* -- In inflation-adjusted dollars, wells can be drilled today to the same depth 20 percent cheaper than in the 1980s.

- *Extract more oil and gas from discovered fields* -- Enhanced recovery now allows industry to produce a higher proportion of the hydrocarbons in discovered reservoirs, leaving less behind.

DOE's technology development program has contributed to this progress. Some of the most notable accomplishments have been:

- **Polycrystalline diamond drill bits** – Nearly 20 years of attempts to increase the durability of drill bits by bonding industrial diamonds to the bit had not been successful until DOE's R&D program found a way to use "diffusion bonding" – an outgrowth of defense research – to permanently adhere the diamond cutters to the bit. The resulting polycrystalline diamond drill bit has shown its ruggedness by drilling 20,000 feet without a bit change. In time-critical drilling, the bit can save as much as $1 million per well. Now, the bits make up at least one-third of the worldwide drill bit market, and DOE is working with universities and industrial groups to continue improving the technology. Microwave-hardened drill bits may be the next major advance coming from DOE's R&D program.

- **4-dimensional seismic imaging** – One of the most significant advances in petroleum technology has been the development of 3-D seismic imaging which gives producers the ability to "see" potential oil- and gas-bearing formations in three spatial dimensions. In recent years, a DOE cost-shared project showed that imaging technology did not have to limited to only three dimensions. A fourth – time – could be added to reveal entirely new and valuable data about the productive potential of an oil reservoir. 4-dimensional seismic imaging gives petroleum engineers a way of visualizing how fluids move through reservoirs, revealing zones where oil is being drained from the formation and other zones

where oil remains untapped. Because of DOE's, 4-D seismic technology now accounts for more than $500 million in commercial oil and gas services in the Gulf of Mexico alone.

- **Cross-Well Imaging** – "Cross-well" seismic imaging technology was first developed in DOE's oil and gas research at a national laboratory. This work expanded the use of seismic waves to image the reservoir by applying the technology downhole between wells rather than from the surface. This new seismic system generates images with much greater clarity, for example, surface seismic can detect features as small as 50 feet, cross-well imaging can detect features as small as 5 feet.

In recent years, DOE's petroleum and natural gas program has increasingly recognized the technology needs of the smaller, independent oil producer. Today this segment of the industry accounts for 40% of the crude oil produced in the United States (and 50% of the oil produced in the lower 48 States) along with 66% of the nation's natural gas production. Nearly 85% of all the wells now drilled in the United States are drilled for and by independent producers.

DOE's partnership efforts with smaller, independent producers have led to notable successes and active technology transfer efforts to neighboring producers and fields. For example:

- **New Life for an Abandoned Field** – An abandoned Bakersfield, CA, oil lease was brought back into production in 1995 in a DOE program that provided cost-sharing for trials of promising, but largely unproven technology. Earlier this year, the Department announced that the field has now produced more than a million barrels of oil – nearly half as much as the field produced in its first 80 years of production. More importantly, because of the success, oil is flowing from 100 new privately funded wells in the immediate vicinity.

- **An Acid Test of a New Technique** – In an oilfield in downtown Los Angeles, a small producer applied for and received a DOE grant to test a new type of acid treatment to remove scale and other deposits that had gradually clogged production from his marginal wells. The treatment, which avoids the long-term damage to the formation common to other acid methods, proved to be a major success. Oil from the treated wells is now flowing at 4 times the pre-treatment rate, and the technique is being made available to other producers facing similar production obstacles.

New innovations can also take the form of better ways to improve environmental compliance. DOE's oil and gas program continues to work with a variety of government and private sector partners to lower the costs and improve the effectiveness of environmental compliance methods. For example:

- **The Risk Based Data Management System** – Developed in a cooperative effort between DOE and the Ground Water Protection Council, this PC-based computer system is now being used by 17 states to make better regulatory and resource management decisions. These states have already recorded more than $20 million in regulatory cost savings while, at the same time, improving their confidence that decisions are economically and environmentally sound.

- **Cleaning Contaminated Soils** – A DOE national laboratory project has shown that software and data collection techniques originally developed to clean up Cold War defense sites could help save the nation's oil and gas producers millions of dollars in cleaning up soils contaminated with naturally occurring radioactive material. Using portable detection equipment and a unique DOE-developed statistical software program, researchers showed how a the costs of locating and cleaning up a contaminated petroleum pipe yard could be reduced by as much as 90%.

Conclusion

When Vice President Cheney presented the report of the National Energy Policy Development Group to the President last month, he prefaced it with the statement:

> "[The report] envisions a comprehensive long-term strategy that uses leading edge technology to produce an integrated energy, environmental and economic policy."

Technology is a core element of the President's National Energy Policy because technology R&D has played a major role in bringing about the energy successes of the past 20 years. Advances in clean coal technologies have enabled coal to maintain its position as a reliable, low cost provider of electricity. Advances in turbine technology have encouraged the reentry of natural gas into electric power generation. Advances in drilling and production technologies, such as new seismic imaging and high-strength drill bits, have opened up opportunities for increased oil and gas production with higher success rates and lower costs.

Our goal at the Energy Department in the future is to continue to foster these types of technological advances through partnerships with the private sector. Our challenge is to determine where the government's role can be most productive and beneficial to the national need for affordable, reliable and environmentally clean energy.

With fossil fuels now providing 85% of the nation's primary energy – an amount that could increase to nearly 88% by 2020 – we take this challenge very seriously.

Thank you for the opportunity to describe many of our accomplishments to date.